

What is Claimed is:

1. A high frequency module comprising:

a first dielectric substrate provided with a first and a
5 second waveguide;

a second dielectric substrate laminated on said first
dielectric substrate and provided with a first cavity and a
second cavity, disposed so as to be separate from each other,
and said first and second waveguides;

10 a third dielectric substrate laminated on said second
dielectric substrate and having a third cavity, inside of which
is positioned said first cavity, and a fourth cavity, inside of
which is positioned said second cavity, disposed apart from
said third cavity and having a slot for communicating to said
15 third cavity, with said first and second waveguides
respectively provided outside said third and fourth cavities;

a metal conductor provided so as to seal said third and
fourth cavities;

20 a plurality of first high frequency circuits installed
within said first cavity;

a plurality of second high frequency circuits installed
within said second cavity;

a first connection line provided within said
communicating slot and connecting between said first and second
25 high frequency circuits; and

a second and third connection line respectively
connecting said first and second high frequency circuits with
said first and second waveguides.

2. The high frequency module according to claim 1, wherein said first or second waveguide consists of a plurality of waveguides disposed along the periphery of said third or fourth cavity, said plurality of waveguides being disposed at mutually symmetrical positions with respect to said first cavity.

3. The high frequency module according to claim 1, wherein said first and second high frequency circuits respectively comprise receiving system circuitry and transmitting system circuitry.

4. The high frequency module according to claim 1, wherein said second and third connection lines are laminated between said second dielectric substrate and third dielectric substrate, and have feed-throughs.

5. The high frequency module according to claim 1, wherein said second and third connection lines perform signal transmission between RF signals carried in connection lines and RF signals carried in waveguides on front and back sides of said second dielectric substrate.

6. The high frequency module according to claim 1, wherein said second and third connection lines are disposed within slots formed on said third dielectric substrate, and joined on waveguide formed by through-hole provided in said first and second dielectric substrates.

7. The high frequency module according to claim 1, wherein
said first dielectric substrate is provided with a transmission
line for carrying a bias signal or an IF signal; said first
5 high frequency circuit is installed within said first cavity
and connected to said transmission line via through-holes
provided on said first or second dielectric substrate; and said
second high frequency circuit is installed within said second
cavity and connected to said transmission line via through-
10 holes provided on said first or second dielectric substrate.

8. The high frequency module according to claim 1, wherein
said high frequency module is provided thereunder with a metal
carrier having a coupling member for coupling with an external
15 apparatus.

9. The high frequency module according to claim 1, wherein
on at least a portion of the cavity periphery and a portion of
the bottom surface of said first to fourth cavities is provided
20 a metal conductor.

10. The high frequency module according to claim 1, wherein
one cavity among said first to fourth cavities is provided with
a plurality of holes having continuity to ground so as to
25 enclose the cavity near the cavity periphery.

11. The high frequency module according to claim 1, wherein
one cavity among said first to fourth cavities is provided with

a plurality of holes having continuity to ground at the cavity periphery.

12. The high frequency module according to claim 11, wherein
5 said holes are through-holes split vertically in half and embedded in the cavity periphery.

13. The high frequency module according to claim 1, wherein
one cavity among said first to fourth cavities is metallized at
10 a position removed from the vicinity of said connection lines in the cavity periphery.

14. The high frequency module according to claim 1, further comprising:

15 a first oscillator for outputting high frequency modulating signal;

a power divider for dividing the power of the output of said first oscillator;

a multiplier for doubling the frequency of one output of
20 said power divider and outputting a transmitting signal;

a second oscillator for outputting an intermediate frequency signal into two directions;

an even harmonic high frequency mixer for outputting a video signal having frequencies of the sum and difference of
25 the doubled frequency of the other output of said power divider and frequency of output of said second oscillator;

a plurality of amplifiers disposed to correspond to the number of existing waveguides and for performing low-noise

amplification of receiving signals obtained from each waveguide;

a power combiner for combining the power of said amplifier outputs;

5 a first fundamental mixer for receiving and converting the frequency of the output of said power combiner and the output of said even harmonic high frequency mixer and outputting an IF signal; and

10 a second fundamental mixer for receiving and converting the frequency of the IF signal that is output from said first fundamental mixer and the other output of said second oscillator and outputting a video signal; wherein

15 said first oscillator, power divider, multiplier, even harmonic high frequency mixer, amplifiers, and first fundamental mixer are mounted within said first and second cavities in said high frequency module.

15. The high frequency module according to claim 1, further comprising:

20 an oscillator for outputting high frequency modulating signal;

a power divider for dividing the power of the output of said oscillator;

25 a multiplier for doubling the frequency of one output of said power divider and outputting a transmitting signal;

a switch having a number of channels corresponding to a plurality of waveguides obtaining receiving signals and capable of selecting said waveguide; and

an even harmonic high frequency mixer for outputting a video signal having frequencies of the sum and difference of the doubled frequency of the other output of said power divider and the output frequency of said switch; wherein

5 said oscillator, power divider, multiplier, switch, and even harmonic high frequency mixer are mounted within said first and second cavities in said high frequency module.

16. The high frequency module according to claim 1, further comprising:

10 a first oscillator for outputting high frequency modulating signal;

 a power divider for dividing the power of the output of the first oscillator;

15 a multiplier for doubling the frequency of one output of said power divider and outputting a transmitting signal;

 a second oscillator for outputting an intermediate frequency signal into two directions;

20 an even harmonic high frequency mixer for outputting a signal having frequencies of the sum and difference of the doubled frequency of the other output of said power divider and the output frequency of said second oscillator;

25 a switch having a number of channels corresponding to a plurality of waveguides obtaining receiving signals and capable of selecting said waveguide;

 a first fundamental mixer for receiving and converting the frequency of the output of said switch and the output of

said even harmonic high frequency mixer and outputting an IF signal; and

a second fundamental mixer for receiving and converting the frequency of the IF signal that is output from said
5 fundamental mixer and the other output of said second oscillator and outputting a video signal; wherein

said first oscillator, power divider, multiplier, even harmonic high frequency mixer, switch, and first fundamental mixer are mounted within said first and second cavities in said
10 high frequency module.

17. The high frequency module according to claim 1, further comprising:

an oscillator for outputting a high frequency modulating
15 signal;

an N-multiplier for multiplying by N (where N is an integer greater than or equal to 2) the output frequency of said oscillator;

a power divider for dividing the power of the output of
20 said N-multiplier;

a multiplier for doubling the frequency of one output of said power divider and outputting a transmitting signal;

a switch having a number of channels corresponding to a plurality of waveguides obtaining receiving signals and capable
25 of selecting said waveguide; and

an even harmonic high frequency mixer for outputting a video signal having frequencies of the sum and difference of the doubled frequency of the other output of said power divider

and the frequency of the receiving signal obtained through said switch; wherein

said oscillator, power divider, multiplier, N-multiplier, switch, and even harmonic high frequency mixer are mounted
5 within said first and second cavities in said high frequency module.

18. The high frequency module according to claim 1, further comprising:

10 an oscillator for outputting a high frequency modulating signal;

a power divider for dividing the power of the output of said oscillator;

15 a multiplier for doubling the frequency of one output of said power divider and outputting a transmitting signal;

a switch having a number of channels corresponding to a plurality of waveguides for outputting transmitting signals and capable of selecting said waveguide and conducting the transmitting signal; and

20 an even harmonic high frequency mixer for outputting a video signal having frequencies of the sum and difference of the doubled frequency of the other output of said power divider and frequency of receiving signal obtained from waveguide differing from said waveguide; wherein

25 said oscillator, power divider, multiplier, switch, and even harmonic high frequency mixer are mounted within said first and second cavities in said high frequency module.

19. The high frequency module according to claim 15, wherein said even harmonic high frequency mixer comprises a built-in anti-parallel diode pair connecting in parallel two diodes of reverse polarity.

5

20. A high frequency module comprising:

a first dielectric substrate provided with a first and second waveguide;

a second dielectric substrate laminated on said first dielectric substrate and provided with a first cavity and a second cavity disposed so as to be separate from each other, and said first and second waveguides;

a metal conductor having a third cavity, in which is positioned inside said first cavity, and a fourth cavity inside which is positioned said second cavity, disposed apart from said third cavity and having a slot for communicating to said third cavity, with said first and second waveguides respectively provided outside said third and fourth cavities;

a plurality of first high frequency circuits installed within said first cavity;

a plurality of second high frequency circuit installed within said second cavity;

a first connection line provided within said communicating slot and connecting between said first and second high frequency circuits; and

a second and third connection line for respectively connecting said first and second high frequency circuits with said first and second waveguides.

21. The high frequency module according to claim 20, wherein said metal conductor is provided with a hollow forming said communicating slot on joining surface with said second dielectric, and in said second dielectric substrate are formed a plurality of holes having continuity to ground at positions where said metal conductor faces said second dielectric substrate along said communicating slot.

22. The high frequency module according to claim 20, wherein in said metal conductor is provided a tunnel-shaped slot including said first connection line, said slot having dimensions of waveguide corresponding to desired cutoff frequency.

23. The high frequency module according to claim 20, wherein said first dielectric substrate is provided with a transmission line for carrying a bias signal or an IF signal, said first high frequency circuit is installed within said first cavity and connected to said transmission line via through-holes provided on said first or second dielectric substrate, said second high frequency circuit is installed within said second cavity and connected to said transmission line via through-holes provided on said first or second dielectric substrate.

24. The high frequency module according to claim 20, wherein on the bottom surface of said high frequency module is provided

a metal carrier having coupling member for coupling with external apparatus.

25. The high frequency module according to claim 20, wherein
5 on at least a portion of the cavity periphery and a portion of the bottom surface of said first to fourth cavities is provided a metal conductor.

26. The high frequency module according to claim 20, wherein
10 one cavity among said first to fourth cavities is provided with a plurality of holes having continuity to ground so as to enclose the cavity near the cavity periphery.

27. The high frequency module according to claim 20, wherein
15 one cavity among said first to fourth cavities is provided with a plurality of holes having continuity to ground at the cavity periphery.

28. The high frequency module according to claim 27, wherein
20 said holes are though-holes split vertically in half and embedded in the cavity periphery.

29. The high frequency module according to claim 20, wherein
one cavity among said first to fourth cavities is metallized at
25 a position removed from vicinity of said connection lines in the cavity periphery.

30. The high frequency module according to claim 20, further comprising:

a first oscillator for outputting high frequency modulating signal;

5 a power divider for dividing the power of the output of said first oscillator;

a multiplier for doubling the frequency of one output of said power divider and outputting a transmitting signal;

10 a second oscillator for outputting an intermediate frequency signal into two directions;

an even harmonic high frequency mixer for outputting a video signal having frequencies of the sum and difference of the doubled frequency of the other output of said power divider and frequency of output of said second oscillator;

15 a plurality of amplifiers disposed to correspond to the number of existing waveguides and for performing low-noise amplification of receiving signals obtained from each waveguide;

20 a power combiner for combining the power of said amplifier outputs;

a first fundamental mixer for receiving and converting the frequency of the output of said power combiner and the output of said even harmonic high frequency mixer and outputting an IF signal; and

25 a second fundamental mixer for receiving and converting the frequency of the IF signal that is output from said first fundamental mixer and the other output of said second oscillator and outputting a video signal; wherein

said first oscillator, power divider, multiplier, even harmonic high frequency mixer, amplifiers, and first fundamental mixer are mounted within said first and second cavities in said high frequency module.

5

31. The high frequency module according to claim 20, further comprising:

an oscillator for outputting high frequency modulating signal;

10 a power divider for dividing the power of the output of said oscillator;

a multiplier for doubling the frequency of one output of said power divider and outputting a transmitting signal;

15 a switch having a number of channels corresponding to a plurality of waveguides obtaining receiving signals and capable of selecting said waveguide; and

an even harmonic high frequency mixer for outputting a video signal having frequencies of the sum and difference of the doubled frequency of the other output of said power divider
20 and the output frequency of said switch; wherein

said oscillator, power divider, multiplier, switch, and even harmonic high frequency mixer are mounted within said first and second cavities in said high frequency module.

25 32. The high frequency module according to claim 20, further comprising:

a first oscillator for outputting high frequency modulating signal;

1 a power divider for dividing the power of the output of
the first oscillator;

2 a multiplier for doubling the frequency of one output of
said power divider and outputting a transmitting signal;

5 a second oscillator for outputting an intermediate
frequency signal into two directions;

10 an even harmonic high frequency mixer for outputting a
signal having frequencies of the sum and difference of the
doubled frequency of the other output of said power divider and
the output frequency of said second oscillator;

15 a switch having a number of channels corresponding to a
plurality of waveguides obtaining receiving signals and capable
of selecting said waveguide;

20 a first fundamental mixer for receiving and converting
the frequency of the output of said switch and the output of
said even harmonic high frequency mixer and outputting an IF
signal; and

25 a second fundamental mixer for receiving and converting
the frequency of the IF signal that is output from said
fundamental mixer and the other output of said second
oscillator and outputting a video signal; wherein

said first oscillator, power divider, multiplier, even
harmonic high frequency mixer, switch, and first fundamental
mixer are mounted within said first and second cavities in said
high frequency module.

33. The high frequency module according to claim 20, further
comprising:

an oscillator for outputting high frequency modulating signal;

an N-multiplier for multiplying by N (where N is an integer greater than or equal to 2) the output frequency of said oscillator;

a power divider for dividing the power of the output of said N-multiplier;

a multiplier for doubling the frequency of one output of said power divider and outputting a transmitting signal;

a switch having a number of channels corresponding to a plurality of waveguides obtaining receiving signals and capable of selecting said waveguide; and

an even harmonic high frequency mixer for outputting a video signal having frequencies of the sum and difference of the doubled frequency of the other output of said power divider and the frequency of the receiving signal obtained through said switch; wherein

said oscillator, power divider, multiplier, N-multiplier, switch, and even harmonic high frequency mixer are mounted within said first and second cavities in said high frequency module.

34. The high frequency module according to claim 20, further comprising:

an oscillator for outputting a high frequency modulating signal;

a power divider for dividing the power of the output of said oscillator;

a multiplier for doubling the frequency of one output of said power divider and outputting a transmitting signal;

a switch having a number of channels corresponding to a plurality of waveguides for outputting transmitting signals and
5 capable of selecting said waveguide and conducting the transmitting signal; and

an even harmonic high frequency mixer for outputting a video signal having frequencies of the sum and difference of the doubled frequency of the other output of said power divider and the frequency of receiving signal obtained from waveguide differing from said waveguide; wherein

said oscillator, power divider, multiplier, switch, and even harmonic high frequency mixer are mounted within said first and second cavities in said high frequency module.

35. The high frequency module according to claim 20, wherein said even harmonic high frequency mixer comprises a built-in anti-parallel diode pair connecting in parallel two diodes of reverse polarity.